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Comparison of the video-assisted thoracoscopic surgical techniques in primary spontan pneumothorax

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Abstract
Aim: Video-assisted thoracoscopic surgery (VATS) is the gold standard for surgical treatment of primary spontaneous pneumothorax (PSP). This study aimed to analyze VATS techniques for PSP.
Material and Methods: In this study, 285 patients who underwent VATS for PSP were included. Patients were divided into three groups as follows: (group WR+PA; n=87) wedge resection + pleural abrasion, (group WR+PP; n=118) wedge resection + pleurectomy, and (group PP; n=80) isolated pleurectomy. The patients were divided into two groups as patients with wedge resection (WR; n = 205) and patients without wedge resection (nonWR; n = 80). Medical records of patients were reviewed retrospectively.
Results: Recurrence rates after VATS for PSP were 5.7% (5/87) in group WR+PA, 5.9% (7/118) in group WR+PP, and 3.8% (3/80) in group PP (p: 0.773). Operation time was significantly longer in group WR+PP compared to group WR+PA and group PP (p: 0.001). Hemorrhaging requiring thoracotomy occurred in three (1.05%, 3/285) patients, and there were no statistically significant differences between the groups. While prolonged air leakage was significantly longer in non-WR than WR patients (7.5% vs. 1.9%, p: 0.003), recurrence rates were not statistically significant in both groups (3.8% vs. 5.9%, p: 0.57).
Discussion: VATS techniques for PSP had similar results concerning recurrence and hemorrhage. Wedge resection, performed blindly does not reduce the rate of recurrence but prevents prolonged air leakage. Pleural abrasion, which is a less invasive method, can be chosen since lung resection may be required in the following years.

Keywords
Pneumothorax; Pleural abrasion; Pleurectomy; Wedge resection

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Introduction

Pneumothorax is the lung collapsed as a result of free air collection in the space between the lung and chest wall. Primary spontaneous pneumothorax (PSP) continues to be a public health burden. The incidence of PSP has been estimated at 7.4 to 18/100000 in the male population and 1.2 to 6/100000 in the female population [1]. PSP occurs in healthy individuals who do not have any additional lung disease, usually by air passage from the alveoli to the pleural space that arises from emphysema-like changes in the lung apex [2]. PSP is accompanied by shortness of breath and chest pain that developed suddenly without any symptoms. Symptoms can be severe or mild. The treatment options are observation, oxygen therapy, simple aspiration, tube thoracostomy, sclerosing agent delivery, thoracoscopy, and thoracotomy.

Surgery is performed in cases of recurrence of PSP. Some authors have recommended surgery treatment in the first episode of pneumothorax, both to prevent recurrent tube thoracostomy and recurrent hospitalization and to reduce hospital stay [3,4]. Many surgeons carry out mechanical or chemical pleurodesis in addition to apical wedge resection. The primary surgical purpose of PSP is to provide extensive adhesions between the parietal pleura and visceral pleura to prevent the creation of free air in the pleural space. Our study aimed to detect the differences and results of surgical procedures.

Material and Methods

This study included 273 patients diagnosed with PSP and treated with VATS between 2007 and 2012. Twelve patients were evaluated as two separate cases because they were operated on bilaterally due to pneumothorax, and the final results are reported as 285 cases. Patients who had no traumatic symptoms on their historical and clinical/radiological findings or any signs of lung disease were considered as PSP.

Age, gender, operation indication, pleurodesis technique, whether or not a wedge resection was performed, the presence of bulla or bleb during thoracoscopy, pathology reports, drain removal time, hospital stay, duration of surgery, follow-up period, and the presence of complications were recorded. The minimum follow-up period was 24 months. Patients who developed a recurrence were recorded by contacting the hospital records administration and the telephone number provided in the patient details. Operation indications were recurrent pneumothorax, bilateral pneumothorax, contralateral pneumothorax, and the presence of an air leak after the tube thoracostomy for more than seven days. Surgery was recommended for all patients who had a second episode. Tube thoracostomy and closed underwater drainage were applied for patients with respiratory stress/hypoxia who could not be operated on for any reason within 24 hours and for patients who did not consent to surgery. Nasal oxygen therapy of 2–3 L/min was applied to patients with a scheduled operation.

Three different surgical techniques performed by different surgeons in the same clinic were examined. The first group received pleural abrasion with wedge resection (WR+PA), the second group underwent pleural pleurectomy (WR+PP) with wedge resection, and the third group received a pleural pleurectomy without wedge resection by cauterizing the small bullae (<2 cm) with endograspers after considering Vanderschueren's classification (PP).

Pleurectomy was limited to only the parietal pleura. The mediastinal and diaphragmatic pleura was not touched, and phrenic nerve and diaphragmatic motility were preserved. The pleurectomy group peeled the entire parietal pleura from the fifth intercostal space. The limits of the planned pleurectomy were determined by drawing lines parallel to the vertebral column from the posterior to the internal mammary veins from the anterior. These lines were combined in the apex. The parietal pleura was held at the top junction with thoracoscopic forceps and began to separate from the thoracic wall by blunt dissection. The created pleural flap was dissected until the port of the camera port was dissected and excised. The abrasion group led to petechiae on a large parietal pleural surface as much as possible using a gas buffer or a small mesh piece.

Statistical Analysis

Statistical analysis was performed using SPSS 22 for IBM (IBM SPSS, Turkey) programs. The appropriateness of the parameters to normal distribution was assessed using the Shapiro-Wilk's test, and it was determined that the settings were not distributed normally. In addition to descriptive statistical methods (Mean, Standard deviation, frequency), the Kruskal-Wallis test was used to compare the parameters according to the surgical techniques, and the Mann-Whitney U test was used to determine the group that caused the difference. The Mann-Whitney U test was used to compare the parameters between the two groups. In the comparison of qualitative data, the Chi-Square test, Fisher's Exact Chi-Square test, and Continuity (Yates) correction were used. Significance was evaluated at the level of $p < 0.05$.

Results

In this study, we investigated 285 cases among which, 261 (91.6%) were male and 24 (8.4%) were female. The median age was 25 years (range, 15–43 years old). The approach was right in 167 patients and left in 118 patients. The indications for surgery were as follows: recurrent ipsilateral pneumothorax in 215 cases (75.4%), prolonged air leak in 48 cases (16.8%), contralateral pneumothorax in 17 cases (6%), and bilateral pneumothorax in 5 cases (1.8%). The median follow-up time was 50 months (range, 24–95 months). The median operation time was 90 min (range, 60-120 min). The median drain removal was four days (range, 1-10 days) and the median hospital stay was four days (range, 1-11 days). Hemorrhaging requiring rethoracotomy occurred in three (1.05%) patients, prolonged air leak (>7 days) was seen in 11 patients (3.85%). Additional interventions were not applied to patients with a prolonged air leak when a follow-up thoracostomy tube was sufficient. Recurrence was seen in 15 (5.3%) cases. Intraoperative or postoperative mortality was not observed. Emphysematous changes were detected in the pathology results in 86.8% of the 205 cases who underwent wedge resection. All pleural samples were reported as chronic pleuritis.

Three operative techniques were evaluated: WR+PA in 87 patients, WR+PP in 118 patients, and PP in 80 patients. There were no statistically significant differences in gender, age, distribution of age, and side of pneumothorax (Table 1).

Table 1. Patient characteristics and indications for operations

		WR+PA N=87	WR+PP N=118	PP N=80	p
Gender:					
Male		74 (85.1)	114 (96.6)	73 (91.2)	0,004
Female		13(14.9)	4 (3.4)	7 (8.8)	
Side					
Right		53 (60.9)	68 (57.6)	46 (57.5)	0,636
Left		34 (39.1)	50 (42.4)	34 (42.5)	
Age; years		25 (15-43)	25 (16-42)	25 (15-40)	0,632
Age:	15-19	17 (19.5)	25 (21.2)	16 (20)	
	20-29	55 (63.2)	64 (54.2)	44 (55)	
	30-39	12 (13.8)	26 (22)	16 (20)	
	40-43	3 (3.5)	3 (2.6)	4 (5)	
Indications for operations:					
Ipsilateral pneumothorax		62 (71.3)	92 (78)	60 ()	0,264
Contralateral pneumothorax		10 (16.1)	5 (16.9)	2 ()	
Prolonged air leak		14 (11.5)	20 (4.2)	14 ()	
Bilateral pneumothorax		1 (1.1)	1 (0.8)	4 ()	

Values are expressed as median (min-max. range) or n (%)

Table 2. Comparison of surgical techniques

	WR+PA N=87	WR+PP N=118	PP N=80	p
Operation time (min)	85 (60-120)	90 (60-120)	86.5 (50-100)	0.001
Drain removal (days)	3 (1-10)	1-7 (3)	4 (2-7)	0.816
Hospital length of stay (days)	4 (1-11)	1-8 (4)	4 (2-9)	0.687
Drain amount (ml)	100 (50-700)	100 (50-800)	100 (50-600)	0.958
Prolonged air leakage	3 (%3.4)	2 (%1.7)	6 (%7.5)	0.112
Recurrence	5 (%5.7)	7 (%5.9)	3 (%3.8)	0.773

Values are expressed as median (min-max. range) or n (%)

Table 3. Comparison of wedge resection and nonwedge resection

	WR n = 205	Non-WR n = 80	p
Operation time (min)	90 (60-120)	86.5 (50-100)	0.001
Drain removal (days)	3 (1-10)	4 (2-7)	0.81
Hospital length of stay (days)	4 (1-11)	4 (2-9)	0.82
Drain amount (ml)	100 (50-800)	100 (50-600)	0.77
Prolonged air leak	4 (%1.9)	6 (%7.5)	0.03
Recurrence	12 (%5.9)	3 (%3.8)	0.57

Values are expressed as median (min-max. range) or n (%)

There was no statistically significant difference between the three groups in terms of drain removal day, length of hospital stay, the volume of drainage, and complications. Operation time was significantly longer in the WR+PP group than the other groups. The recurrence rate was similar between the three groups: 5.7%, % 5.9%, and %3.8, respectively. Prolonged air leakage was more seen in the PP group than the other groups (3.4% vs. 1.7% vs. 7.5%). However, there was no statistically significant difference (Table 2).

The operation time for the wedge resection was significantly longer than in patients who did not undergo wedge resection, regardless of mechanical pleurodesis. There were no statistically significant differences in the days of drain removal, length of hospital stay, the volume of drainage, and recurrence rate. The prolonged air leak was more seen in the wedge resection group than the non-wedge group (7.5% vs. 1.9, p: 0.03) (Table 3).

All patients with recurrence after surgery were males. The median age was 22 years (17-31). Ten patients underwent surgery on the right side, and five patients on the left side. The first indication for surgery was ipsilateral pneumothorax in all patients. Bulla or bleb was seen in 80% (12/15) of the patients. The time between recurrence and the first operation ranged from 2 to 36 months. Recurrence time was less than three months in eight patients, three months to one year in two patients, and more than one year in five patients. The patients who developed recurrent pneumothorax were treated with inhaled oxygen therapy (5 patients), tube thoracostomy (8 patients), and VATS (2 patients).

Discussion

In our study, we did not find any difference between pleural abrasion and pleurectomy groups concerning the recurrence rate and hemorrhage requiring thoracotomy. Shaikhrezai et al. suggested a bullectomy with pleural abrasion, particularly for young patients and reported that pleurectomy was an aggressive approach that is best avoided unless absolutely required [5]. Rena et al. reported that pleural abrasion is safer than apical pleurectomy. While the rate of postoperative hemorrhage is significantly higher in parietal pleurectomy than pleural abrasion (7.4% and 0.9%), a significant difference was not reported in recurrence rates (4.6% and 6.2%) [6]. While the debates on mechanical pleurodesis methods have continued in the literature, Min et al. discussed the necessity of mechanical pleurodesis. They stated that wedge resection alone was successful in preventing recurrence after PSP surgery, and mechanical pleurodesis causes additional trauma. The recurrence rate was reported as 6.3% in patients with only wedge resection [7]. This rate was close to many studies, including our study [8,9].

PSP treatment aims to prevent the recurrence of disease by stopping air leaks [10]. The formation of free air in the pleural cavity is avoided by providing diffuse adhesions between the parietal pleura and visceral pleura. Pleurodesis can be carried out by pleurectomy, pleural abrasion, or chemicals [11]. The purpose of implementing pleurodesis is to provide adhesions between the parietal and visceral pleura. Cardillo et al. used video thoracoscopic poudrage with 2 g talc to treat PSP in 861 patients. The reported recurrence rate of patients in whom talc had been applied was 2.41%, and it was 1.35% in patients with bullae excision treated with talc. The success rate of that study was 98%. The authors argued that talc poudrage had a high success rate and could be used safely to treat PSP [12, 13]. However, talc could cause restrictive respiratory disorders. In the study, which was conducted with 75 patients followed for 22-35 years, there was mild restrictive lung function impairment (89% of the estimated total lung capacity) observed after talc poudrage [14]. Pleurodesis with talc resulted in talc deposits

forming in the mediastinum, mediastinal pleura, pericardium, lung, and liver, predisposing the pleura to thickening due to an inflammatory reaction in the parenchyma and pleura. Pulmonary compliance reduces when pleural thickening occurs [15]. Thus, talc is not used to treat PSP, which is a benign disease in our clinic. Moreover, talc pleurodesis in young patients complicates lung resection and lung transplantation that may be required in the future.

Many authors have suggested apical resection to treat pneumothorax, even if blebs or bullae and apical lesions are not seen [9,12,16]. A spontaneous pneumothorax usually occurs with a primarily localized rupture of apical emphysematous blebs. Although many mechanisms have been discussed, subpleural blebs are formed by exposing alveoli to higher than average inflation pressures for an extended period. Pleural pressure can be more negative at the apex, causing a rupture and a pneumothorax. The purpose of a wedge resection is to remove blebs that cannot be detected intraoperatively and provide apical adhesions. In our study, a group of surgeons believed that unnecessary wedge resections do not prevent the accumulation of air in the intrapleural space and do not contribute to apical adhesions. After the operation, six (7.5%) of the 80 cases in the series experienced prolonged air leaks lasting more than seven days, and the recurrence rate was 3.8%. While the occurrence of prolonged air leak following wedge resection was higher than in cases where mechanical pleurodesis was performed, the recurrence rate was low. However, no significant difference was observed. Six patients with a prolonged air leak were discharged on a postoperative day four with a Heimlich valve, and their drainage was terminated after seven days of monitoring. No recurrence was seen during their follow-up.

Subpleural blebs or bullae, referred to as emphysema-like changes, are seen in 75-100% of patients with PSP. Blebs are also found in non-smoking patients with PSP [9]. Our study detected emphysematous changes in 178 (86.8%) of 205 patients who underwent wedge resection. Nine out of 12 patients developed emphysematous changes, two patients had chronic inflammation, and one patient had fibrosis. Although emphysema-like changes are the most common cause of PSP, they are not seen during surgery, and the existence of air leakage at different control points brings to mind the presence of pleural pores [17]. This situation may explain the high recurrence rate of bullae or bleb excision that does not accompany mechanical pleurodesis.

Although PSP treatment modality and timing of surgery remain controversial, a wait-and-see approach is generally acceptable for pleural drainage in selected cases of the first episode of spontaneous pneumothorax [4]. If long-term air leaks occur within seven days after tube thoracostomy in the presence of pneumothorax, surgical treatments should be performed with the first pneumothorax attack in some occupational groups, such as pilot and diver. Some authors have suggested the thoracoscopic treatment for the first attack of pneumothorax due to the increased recurrence rate of pneumothorax after tube thoracostomy treatment. Additional reasons include reducing hospital length of stay and preventing recurrent hospital admissions [18].

Conclusions

The blind apical wedge resection without bleb or bulla detected reduced prolonged air leakage while contributing to lowering the rate of pneumothorax recurrence. There was no difference between pleurectomy and pleural abrasion concerning pneumothorax recurrence and postoperative bleeding. Pleural abrasion, which is a less invasive method, can be chosen since lung resection may be required in the following years. Surgical techniques vary according to the patient and surgeon and will continue to be compared.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

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Conflict of interest

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